Commonwealth of Virginia Emergency Operations Plan
Standard Hazard Mitigation Support Annex 3
(Volume II)

CHAPTER 3

Hazard Identification and Risk Assessment (HIRA)

Section 3.15:
Flooding due to Dam Failure

2010

SECTION 3.15

TABLE OF CONTENTS

TABLES AND FIGURES

Section 3.15: Flooding Due to Dam Failure

Description

Bland County, 1957
Crab Orchard Creek Dam Failure
Source: Mount Rogers PDC 2004 Local HMP

Flooding due to dam failure refers to a collapse, overtopping, breaching, or other failure that causes an uncontrolled release of water or sludge from an impoundment, resulting in downstream flooding. Dam or levee failures can occur with little warning. Intense storms may produce a flood in a few hours or even minutes from upstream locations. Flash floods occur within six hours of the beginning of heavy rainfall, and dam failure may occur within hours of the first signs of breaching. Other failures and breeches can take much longer to occur, from days to weeks, as a result of debris jams or the accumulation of melting snow[1].

Flooding following a dam failure may occur due to any one or a combination of the following causes[2]:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments, or maintain gates, valves, or other operational components;
- Improper design, including the use of improper construction materials and construction practices;
- Negligent operation, including failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway;
- High winds, which can cause significant wave action and result in substantial erosion;
- Intentional criminal acts

The mission of the Virginia Department of Conservation and Recreation (DCR) is to conserve, protect, enhance, and advocate the wise use of the Commonwealth's unique natural, historical, recreational, scenic and cultural resources. DCR's Division of Dam Safety and Floodplain Management administers the Virginia Dam Safety

[1] FEMA Dam Failure http://www.fema.gov/hazard/damfailure/index.shtm
[2] Maryland Hazard Mitigation Plan, 2009

Program, under the authority of the Virginia Soil and Water Conservation Board. The dam safety division regulates impounding structures in the Commonwealth to ensure that they are "properly and safely constructed, maintained and operated."[3] The regulations promulgated to achieve these ends are recorded in the Virginia Administrative Code.[4] Ongoing dam inspections and Virginia's participation in the National Dam Safety Program maintained by FEMA and the U.S. Army Corps of Engineers serve as a preventative measure against dam failures. Disaster recovery programs include assistance to dam owners and local officials in assessing the condition of dams following a flood disaster and assuring the repairs and reconstruction of damaged structures are compliant with the National Flood Insurance Program (NFIP) regulations.

In 2001, Virginia's legislature broadened the definitions of "impounding structure" to bring more dams under regulatory oversight. On February 1, 2008, the Virginia Soil and Water Conservation Board approved major revisions to the Impounding Structure Regulations in the Virginia Administrative Code, changing the dam hazard potential classification system, modifying spillway requirements, requiring dam break inundation zone modeling, expanding emergency action plan requirements, and making a variety of other regulatory changes.

Dams are classified with a hazard potential depending on the downstream losses estimated in event of failure. The recent regulatory revisions bring Virginia's classification system into alignment with the system already used in the National Inventory of Dams maintained by the U.S. Army Corps of Engineers. Hazard potential is not related to the structural integrity of a dam but strictly to the potential for adverse downstream effects if the dam were to fail. Regulatory requirements, such as the frequency of dam inspection, the standards for spillway design, and the extent of emergency operations plans, are dependent upon the dam classification. Table 3.15-1 provides additional information on these classes and the possible effects on downstream areas if dam failure were to occur.

Table 3.15- 1: Dam Classification System in Virginia.

Hazard Potential	Description	Inspection
High	Failure will cause probable loss of life or serious economic damage (to buildings, facilities, major roadways, etc.)	Annual, with inspection by a professional engineer every 2 years.
Significant	Failure may cause loss of human life or appreciable economic damage (to buildings, secondary roadways, etc.)	Annual, with inspection by a professional engineer every 3 years.
Low	Failure would result in no expected loss of human life, and cause no more than minimal economic damage	Annual, with inspection by a professional engineer every 6 years.

[3] Code of Virginia §10.1-605
[4] 4 VAC 50-20, also known as the Impounding Structure Regulations

The owner of each regulated *high*, *significant*, or *low* hazard dam is required to apply to the board for an *Operation and Maintenance Certificate*. The application must include an assessment of the dam by a licensed professional, an *Emergency Action Plan* and the appropriate fee(s), submitted under separate cover. An executed copy of the *Emergency Action Plan* or *Emergency Preparedness Plan* must be filed with the appropriate local emergency official and the Virginia Department of Emergency Management[5].

The Virginia Soil and Water Conservation Board (VSWCB) issues *Regular Operation and Maintenance Certificates* to the dam owner for a period of six years. If a dam has a deficiency but does not pose imminent danger, the board may issue a *Conditional Operation and Maintenance Certificate*, during which time the dam owner is to correct the deficiency. After a dam is certified by the board, annual inspections are required either by a professional engineer or the dam owner, and the *Annual Inspection Report* is submitted to the regional dam safety engineer.

Historic Occurrence

There are no comprehensive databases of historical dam failures or flooding following a dam failure in Virginia. Most failures occur due to lack of maintenance of dam facilities in combination with major precipitation events, such as hurricanes and thunderstorms.

- The muck dam at Saltville broke and flooded the community of Palmertown, killing 19 people and dislodging several homes from their foundations on Christmas Eve in 1924.[6]
- In 1957 the Crab Orchard Creek Dam failed due to heavy rains; no one was hurt, but the estimated damage came to half a million dollars.[7]
- In 1969, Lake Louisa Dam failed as a result of hurricane Camille.[8]
- Hurricane Floyd in 1999 caused twelve unregulated dams to break in eastern Virginia, one being the Cow Creek Dam in Gloucester County.[9]
- Recent failures have included the Timberlake Dam, which killed two in 1995 and cost nearly one million dollars to rebuild, the Powhatan Lakes Dam, which failed due to a heavy storm during the summer of 2004 and caused over one million dollars in damage[10], and Falling Creek Dam in Chesterfield County, which was overtopped during Tropical Storm Gaston flooding in late summer 2004.

[5] Virginia DCR Dam Safety and Floodplain Management
http://www.dcr.virginia.gov/dam_safety_and_floodplains/
[6] From newspaper story, "Charged with Blowing Dam," in the *Marion News*, January 1925. On file in the historical archives at Smyth-Bland Regional Library in Marion.
[7] Mount Rogers Region Local Mitigation Plan
[8] Thomas Jefferson Local Mitigation Plan
[9] Middle Peninsula Local Mitigation Plan
[10] Richmond Local Mitigation Plan

- Several dams failed or were overtopped following Tropical Depression Ernesto in 2006.

Risk Assessment

Although flood inundation maps are a requirement of the current Impounding Structure Regulations[11], Virginia DCR does not currently have this information available in a digital form. Were these maps available, they would illustrate the probable area of flooding downstream of a dam in the event of failure. Lacking such data, this plan's risk assessment was based solely on the USACE National Inventory of Dams.

In 1972, Congress authorized the U.S. Army Corps of Engineers (USACE) to inventory dams located in the United States through the National Dam Inspection Act. The Water Resources Development Act of 1986 authorized USACE to maintain and periodically publish an updated National Inventory of Dams (NID). The Water Resources Development Act of 1996 re-authorized periodic update of the NID by USACE, and continued a funding mechanism. This data set is the source for the general jurisdictional analysis in this plan.[12]

Probability

Predicting the probability of flooding due to dam failure requires a detailed, site-specific engineering analysis for each dam in question. Failure may result from hydrologic and hydraulic design limitations, or from geotechnical or operational factors. The data and time necessary to perform a probabilistic failure analysis for each dam in Virginia is beyond the scope of this plan.

The probability of dam failure due to hydrologic and hydraulic design limitations is related to the regulatory standards for dam spillway design in Virginia. Dams are required to safely pass a spillway design flood (SDF) without failure, as indicated in Table 3.15-2.

Table 3.15- 2: Performance Standards for Dams

Hazard Potential	Spillway Design	Minimum Threshold for Incremental Damage Analysis
High	PMF[13]	.50 PMF
Significant	.50 PMF	100-YR
Low	100-YR	50-YR

[11] 4 VAC 50-20-54
[12] National Inventory of Dams http://crunch.tec.army.mil/nidpublic/webpages/nid.cfm
[13] PMF is the Probable Maximum Flood, resulting from the Probable Maximum Precipitation (PMP) estimated by the National Weather Service based on the most severe combination of meteorologic and hydrologic conditions.

Note that a dam may be designed to a slightly lower standard than the spillway design flood based on a detailed incremental damage analysis showing that using the higher design flood does not significantly worsen downstream flooding. Low hazard dams expected to result in no loss of human life and no economic damage to any property, except the dam owner's, may be exempted from the spillway design standards, as well as many of the otherwise applicable regulations.

Impact & Vulnerability

Failure of dams may result in catastrophic localized damages. Vulnerability to dam failure is dependent on dam operations planning and the nature of downstream development. Depending on the elevation and storage volume of the impoundment, the impact of flooding due to dam failure may include loss of human life, economic losses such as property damage and infrastructure disruption, and environmental impacts such as destruction of habitat. Evaluation of vulnerability and impact is highly dependent on site-specific conditions; no broad-brush approach can be applied at a state-wide level.

Owners of impounding structures are required to have dam break inundation zone maps that meet the standards of the Virginia Impounding Structure Regulations[14]. These maps are filed with the Department of Conservation and Recreation (DCR). The properties that are identified within the dam break zone are recorded in the dam safety emergency action plan for that impoundment. Ideally this data would all be in a digital format that could be used for analysis. DCR has indicated that this information should be available for future revisions of this plan. Such data would greatly improve ability to identify impact and vulnerability due to dam inundation.

Risk

Due to the lack of specific data on dam failure probability or inundation zones, the potential risk to state facilities and critical facilities was not estimated for this revision of the plan. A few simplified GIS analyses based on dam proximity to populated areas were considered, but the results of such analyses would not provide an accurate depiction of actual risk. A detailed pseudo-inundation zone map could be developed using detailed terrain models and certain simplifying assumptions, although such an analysis would represent a significant undertaking. Given that Virginia's new Impounding Structure Regulations require dam break inundation zone mapping, the most efficient course of action is to let DCR compile this data into a usable format.

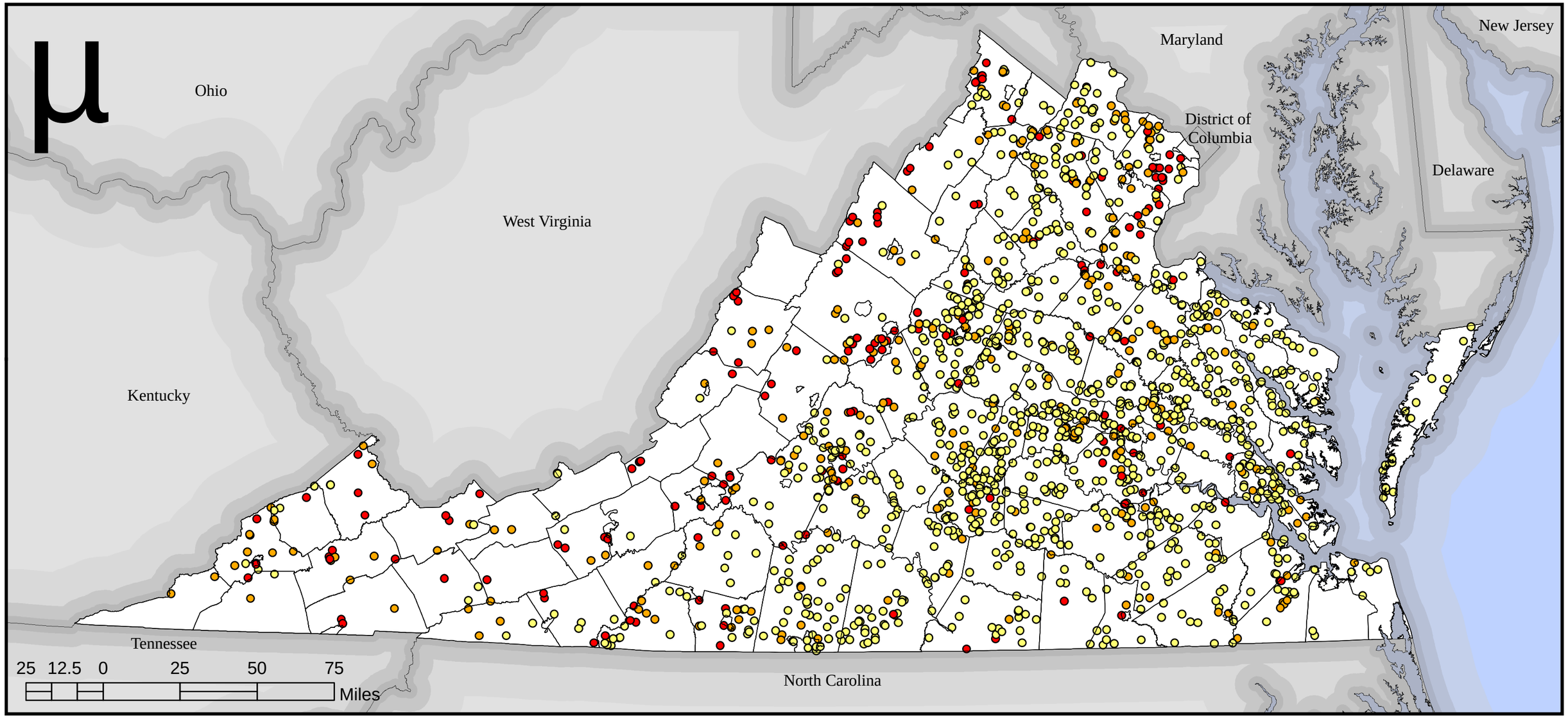
[14] Code of Virginia, Chapter 491 Dam Safety, Flood Prevention and Protection Assistance Fund established, mapping of dam inundation zones. March 8, 2008 http://leg1.state.va.us/cgi-bin/legp504.exe?081+ful+CHAP0491

Based on data from the NID, there are approximately 1,577 dams in the Commonwealth. A majority of the dams in Virginia are classified as Low hazard (72%). Figure 3.15-1 shows the locations of the three hazard classifications in the state.

Private ownership accounts for approximately three-quarters of the dams; over 90% are made of earthen materials and over 50% are classified as recreation purpose. Funding opportunities are very limited for private dams.

Mecklenburg County, Bath County, Louisa County, Spotsylvania County, Franklin County and Dickenson County all have over 100,000 acre-feet of maximum storage area. This is defined as the total storage space in the reservoir below the maximum attainable water surface elevation, including surcharge storage. Mecklenburg County has over 3.4 million acre-feet of maximum storage, most of which is held in the county's 2 high hazard dams. Albemarle County has 72 dams; this is the highest number of dams per jurisdiction followed by Fauquier County, Hanover County, and Pittsylvania County all of which have 45 dams each. Table 3.15-3 summarizes the number of dams per jurisdiction by hazard type and maximum storage capacity.

Figure 3.15-1: Virginia Dam Inventory & Hazard Potential



Center for Geospatial Information Technology

VIRGINIA DEPARTMENT OF EMERGENCY MANAGEMENT

DATA SOURCES:

USACE National Inventory of Dams
VGIN Jurisdictional Boundaries
ESRI State Boundaries

LEGEND:

Downstream Hazard Potential

- High
- Significant
- Low

HAZARD IDENTIFICATION:

Three codes have been established, by NID, to categorize the hazard to downstream areas resulting from failure or misoperation of the dam or facilities.

High: Probable loss of life and/or serious economic damage.
Significant: May cause loss of human life and/or economic damage.
Low: No expected loss of life and/or limited economic damage.

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

Local Plan Risk Assessment

Local plans were reviewed for spatial data sources used, historical occurrences, hazard probabilities, vulnerability, loss estimations, and land use and development trends. When available, this information supplements the text and figures of each of the sections in this revision.

None of the twenty-seven local plans provided loss estimates for flooding due to dam failure. Eighteen plans provided a general description of the hazard; several provided National Inventory of Dams statistics for dams in their region. Southside PDC provided dam inundation zone maps, dam break study, and the emergency notification plan for the John H Kerr dam.

Comparison with Local Ranking

West Piedmont PDC and Southside PDC ranked dam as a high hazard for their regions.

Lenowisco PDC, Mount Rogers PDC, Cumberland Plateau PDC, and Middle Peninsula PDC all ranked dam failure as medium hazard for their regions.

Ten additional plans ranked dam failure as a low hazard, resulting in a local plan average of low for dam failure (section 3.6). The 2010 statewide analysis also has ranked dam failure as low, and is consistent in this regard with the local plans. Section 3.6 (Table 3.6-2) includes the complete ranking of all the local plans.

Changes in Development

The majority of local plans did not specifically address changes in development for each hazard or the effects of changes in development on loss estimates. In most cases overall development patterns were discussed in general. Seventeen of the twenty-seven local plans cite their comprehensive plans for current and future land use changes (section 3.2). Localities and VDEM should work with DCR for future updates to this section. Since dam inundation zone maps are required this information could be used to determine high risk areas for future development. Such data would greatly improve ability to identify impact, vulnerability and loss estimates due to dam inundation.

While figure 3.15-1 displays all of the dams in Virginia from the NID, table 3.15-3 displays all of the regulated dams in the Commonwealth as provided by the Dam Safety Division of the Department of Conservation and Recreation.

Table 3.15-3: Regulated Dams in the Commonwealth

Jurisdiction	Number of High Hazard Dams	Maximum Storage Capacity (AF)	Number of Significant Hazard Dams	Maximum Storage Capacity (AF)	Number of Low Hazard Dams	Maximum Storage Capacity (AF)	Total Number of Dams	Total Maximum Storage Capacity (AF)
Accomack County	0	0	0	0	0	0	0	0
Albemarle County	5	4,187	10	5,313	21	9,632	36	19,142
Alleghany County	1	318	1	1,496	0	0	2	1,814
Amelia County	0	0	0	0	3	2,762	3	2,762
Amherst County	3	3,406	4	10,066	5	1,543	12	15,015
Appomattox County	0	0	0	0	6	4,445	6	4,445
Arlington County	0	0	0	0	0	0	0	0
Augusta County	13	23,560	4	3,030	3	1,462	20	28,052
Bath County	1	1,450	2	1,142	0	0	3	2,592
Bedford County	3	8,033	5	3,953	9	1,177	17	13,163
Bland County	0	0	1	550	0	0	1	550
Botetourt County	3	23,263	1	40	0	0	4	23,303
Brunswick County	1	27,854	0	0	1	2,700	2	30,554
Buchanan County	0	0	0	0	0	0	0	0
Buckingham County	0	0	5	11,910	17	24,956	22	36,866
Campbell County	1	150	3	2,076	8	7,179	12	9,405
Caroline County	2	8,759	5	1,883	4	857	11	11,499
Carroll County	1	7,415	0	0	1	605	2	8,020
Charles City County	0	0	0	0	0	0	0	0
Charlotte County	0	0	1	5,535	13	22,154	14	27,689
Chesterfield County	3	53,091	4	10,745	7	6,828	14	70,664
City of Alexandria	0	0	0	0	0	0	0	0

Jurisdiction	Number of High Hazard Dams	Maximum Storage Capacity (AF)	Number of Significant Hazard Dams	Maximum Storage Capacity (AF)	Number of Low Hazard Dams	Maximum Storage Capacity (AF)	Total Number of Dams	Total Maximum Storage Capacity (AF)
City of Bedford	0	0	0	0	0	0	0	0
City of Bristol	0	0	0	0	0	0	0	0
City of Buena Vista	0	0	0	0	0	0	0	0
City of Charlottesville	0	0	0	0	0	0	0	0
City of Chesapeake	0	0	0	0	0	0	0	0
City of Clifton Forge	0	0	0	0	0	0	0	0
City of Colonial Heights	0	0	0	0	0	0	0	0
City of Covington	0	0	0	0	0	0	0	0
City of Danville	0	0	0	0	0	0	0	0
City of Emporia	0	0	0	0	0	0	0	0
City of Fairfax	0	0	0	0	0	0	0	0
City of Falls Church	0	0	0	0	0	0	0	0
City of Franklin	0	0	0	0	0	0	0	0
City of Fredericksburg	0	0	0	0	1	168	1	168
City of Galax	0	0	0	0	0	0	0	0
City of Hampton	0	0	0	0	0	0	0	0
City of Harrisonburg	0	0	1	122	1	25	2	147
City of Hopewell	0	0	0	0	0	0	0	0
City of Lexington	0	0	0	0	0	0	0	0
City of Lynchburg	1	1,000	1	134	1	3,950	3	5,084
City of Manassas	0	0	1	175	0	0	1	175
City of Manassas Park	0	0	0	0	0	0	0	0

Jurisdiction	Number of High Hazard Dams	Maximum Storage Capacity (AF)	Number of Significant Hazard Dams	Maximum Storage Capacity (AF)	Number of Low Hazard Dams	Maximum Storage Capacity (AF)	Total Number of Dams	Total Maximum Storage Capacity (AF)
City of Martinsville	0	0	0	0	0	0	0	0
City of Newport News	1	886	2	5,150	0	0	3	6,036
City of Norfolk	0	0	0	0	0	0	0	0
City of Norton	2	477	0	0	0	0	2	477
City of Poquoson	0	0	0	0	0	0	0	0
City of Petersburg	0	0	0	0	0	0	0	0
City of Portsmouth	0	0	0	0	0	0	0	0
City of Radford	0	0	0	0	0	0	0	0
City of Richmond	1	110	1	267	0	0	2	377
City of Roanoke	2	177	0	0	0	0	2	177
City of Salem	0	0	0	0	0	0	0	0
City of South Boston	0	0	0	0	0	0	0	0
City of Staunton	0	0	0	0	0	0	0	0
City of Suffolk	4	57,092	3	50,800	4	15,232	11	123,124
City of Virginia Beach	0	0	1	2,647	1	65	2	2,712
City of Waynesboro	0	0	0	0	0	0	0	0
City of Williamsburg	0	0	0	0	0	0	0	0
City of Winchester	0	0	0	0	0	0	0	0
Clarke County	0	0	0	0	1	310	1	310
Craig County	4	6,407	0	0	0	0	4	6,407
Culpeper County	2	12,290	2	3,048	4	3,187	8	18,525
Cumberland County	0	0	1	636	6	2,739	7	3,375

Jurisdiction	Number of High Hazard Dams	Maximum Storage Capacity (AF)	Number of Significant Hazard Dams	Maximum Storage Capacity (AF)	Number of Low Hazard Dams	Maximum Storage Capacity (AF)	Total Number of Dams	Total Maximum Storage Capacity (AF)
Dickenson County	0	0	1	240	3	440	4	680
Dinwiddie County	0	0	2	1,924	0	0	2	1,924
Essex County	0	0	0	0	0	0	0	0
Fairfax County	15	23,088	9	4,389	2	139	26	27,616
Fauquier County	4	11,347	6	3,908	7	1,773	17	17,028
Floyd County	0	0	0	0	0	0	0	0
Fluvanna County	0	0	2	20,100	7	2,479	9	22,579
Franklin County	1	338	1	672	2	391	4	1,401
Frederick County	5	15,495	4	1,799	2	626	11	17,920
Giles County	0	0	0	0	2	390	2	390
Gloucester County	1	20,523	1	931	0	0	2	21,454
Goochland County	0	0	6	6,592	5	2,622	11	9,214
Grayson County	0	0	1	134	1	2,000	2	2,134
Greene County	1	360	4	2,626	5	1,335	10	4,321
Greensville County	0	0	0	0	0	0	0	0
Halifax County	0	0	0	0	4	3,162	4	3,162
Hanover County	0	0	7	2,154	12	4,340	19	6,494
Henrico County	1	131	3	643	2	420	6	1,194
Henry County	3	11,546	6	8,836	7	2,200	16	22,582
Highland County	0	0	0	0	0	0	0	0
Isle of Wight County	0	0	0	0	0	0	0	0
James City County	0	0	4	32,831	10	3,537	14	36,368

Jurisdiction	Number of High Hazard Dams	Maximum Storage Capacity (AF)	Number of Significant Hazard Dams	Maximum Storage Capacity (AF)	Number of Low Hazard Dams	Maximum Storage Capacity (AF)	Total Number of Dams	Total Maximum Storage Capacity (AF)
King and Queen County	0	0	0	0	0	0	0	0
King George County	1	500	0	0	4	953	5	1,453
King William County	0	0	0	0	2	271	2	271
Lancaster County	0	0	0	0	1	190	1	190
Lee County	0	0	1	3,130	0	0	1	3,130
Loudoun County	0	0	10	16,896	12	17,678	22	34,574
Louisa County	0	0	7	15,398	9	11,211	16	26,609
Lunenburg County	0	0	3	686	0	0	3	686
Madison County	0	0	0	0	13	3,178	13	3,178
Mathews County	0	0	0	0	0	0	0	0
Mecklenburg County	0	0	0	0	1	150	1	150
Middlesex County	0	0	0	0	0	0	0	0
Montgomery County	0	0	0	0	0	0	0	0
Nelson County	0	0	3	1,287	2	1,244	5	2,531
New Kent County	1	29,093	5	2,188	0	0	6	31,281
Northampton County	0	0	0	0	0	0	0	0
Northumberland County	0	0	0	0	0	0	0	0
Nottoway County	0	0	0	0	5	3,465	5	3,465
Orange County	2	14,562	1	154	6	4,932	9	19,648
Page County	2	1,729	0	0	0	0	2	1,729
Patrick County	1	59	1	110	8	3,384	10	3,553
Pittsylvania County	1	193	2	8,788	7	4,433	10	13,414
Powhatan County	0	0	0	0	12	6,336	12	6,336
Prince Edward County	2	49,123	1	2,245	18	31,390	21	82,758
Prince George County	0	0	0	0	1	395	1	395

Jurisdiction	Number of High Hazard Dams	Maximum Storage Capacity (AF)	Number of Significant Hazard Dams	Maximum Storage Capacity (AF)	Number of Low Hazard Dams	Maximum Storage Capacity (AF)	Total Number of Dams	Total Maximum Storage Capacity (AF)
Prince William County	6	34,832	8	21,005	4	808	18	56,645
Pulaski County	2	4,915	2	434	0	0	4	5,349
Rappahannock County	0	0	0	0	1	433	1	433
Richmond County	0	0	0	0	0	0	0	0
Roanoke County	2	11,523	1	108	0	0	3	11,631
Rockbridge County	4	13,536	2	500	1	90	7	14,126
Rockingham County	8	25,207	2	1,515	1	77	11	26,799
Russell County	1	8,100	0	0	2	1,397	3	9,497
Scott County	0	0	0	0	1	1,000	1	1,000
Shenandoah County	3	5,272	1	89	0	0	4	5,361
Smyth County	1	2,500	0	0	0	0	1	2,500
Southampton County	0	0	0	0	0	0	0	0
Spotsylvania County	2	24,700	5	33,495	3	3,005	10	61,200
Stafford County	2	264	5	12,533	5	2,846	12	15,643
Surry County	0	0	0	0	1	183	1	183
Sussex County	0	0	0	0	0	0	0	0
Tazewell County	2	3,370	0	0	0	0	2	3,370
Warren County	0	0	6	370	3	309	9	679
Washington County	0	0	1	1,975	0	0	1	1,975
Westmoreland County	0	0	2	2,077	1	2,450	3	4,527
Wise County	6	6,985	2	454	1	1,630	9	9,069
Wythe County	1	2,440	0	0	0	0	1	2,440
York County	0	0	1	5,845	1	7,274	2	13,119
Total	**35**	**552,231**	**188**	**339,779**	**314**	**248,532**	**537**	**1,140,542**

Table 3.15-4: EMAP Analysis

Subject	Detrimental Impacts
Health and Safety of Public	Localized impacts expected to be extensive for inundation area and moderate to light for other affected areas.
Health and Safety of Response Personnel	Unless response personnel are within the inundation area, impacts will be limited.
Continuity of Operations	Damage to facilities/personnel in the area of the event may require temporary relocation of some operations.
Property, Facilities, and Infrastructure	Localized impacts to facilities, property, and infrastructure in the inundation area could be extensive depending on capacity of dam and types of development in inundation areas.
Delivery of Services	Localized disruption of roads, facilities, communications and/or utilities caused by the event may postpone the delivery of some services.
The Environment	Localized impacts expected to be extensive for inundation areas and moderate to light for areas outisde the inundation zone.
Economic and Financial Condition	Economic and financial conditions will be impacted, potentially for long periods of time.
Public Confidence in the Jurisdiction's Governance	Localized impact expected to affect dam owners and local government entities responsible for land use planning.

*****_Table was modeled from the Missouri State Hazard Mitigation Plan_